NON-PROVISIONAL PATENT APPLICATION

FOR

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FOR

UNIVERSAL TRANSPORTABLE COMPRESSED AIR FOAM FIRE FIGHTING SYSTEM

REFERENCE TO RELATED APPLICATION

This Non-Provisional Patent Application is based upon U.S. Provisional Patent Application Serial No. 60/409,717 filed September 10, 2002, and hereby claims the benefit of the embodiments therein and of the filing date thereof.

FIELD OF THE INVENTION

This invention relates to the field of fire fighting, and more particularly, to compressed air foam systems (CAFS) for controlling the flow of fire fighting fluids which employ foam-producing additives to water to be delivered by a hose from a pressurized source, such as a pump, a fire hydrant, or from such other sources, such as a tank, a stream or a lake.

BACKGROUND OF THE INVENTION

There are many situations where it would be desirable to have a compact, relatively portable fire-fighting system readily available, particularly in forest or brush areas or in remotely located neighborhoods where full scale fire-fighting equipment is not readily available or accessible. Such a compact system should, to the extent possible, make use of the most advanced fire-fighting technology available.

The use of foam additives to water in fighting fires is well recognized as a major advance in improving the effectiveness in retarding ignition, extinguishing blazes, preventing re-ignition of burnable materials, and in indicating a coverage in both airborne drops and ground operations. Foam is particularly suited for use in forest or brush areas where it will also act as a wetting agent, exhibiting good cooling capability by blanketing burnable materials, and reducing smoke by the blanketing effect.

This system employs our previously patented foam mixing system, which is the subject of U.S. Patent 5,009,244, assigned to the assignee of the present patent application, which discloses a system for mixing foam concentrate, such as a product of Ansul Wormold Corp. of Marionette, Wisconsin, sold under the trademark ANSUL, with water in such a way that the precise desired proportion of foam concentrate is mixed with water irrespective of the quantity of water supplied to fight a fire. A significant element of this system is a differential pressure valve, the subject of U.S. Patent 5,165,442, which is also assigned to the assignee of the present application. Both of the above patents are hereby incorporated by reference.

Fire fighters are concerned with the ratio of foam concentrate to water and also to the ratio of water/foam concentrate to air. If the foam concentrate provided is too low (below about .2%), this will result in pulsations (water slugs) in the hose. This is because there is not enough foam concentrate in the solution to form foam in the hose. A somewhat higher ratio will yield a "wetter" appearing foam. A still higher ratio will yield a "drier" appearing foam. Varying degrees of dryness or wetness are appropriate for combating different types of fires.

Because the ratio of air to water/foam solution is recognized as being very important to getting the desired type of foam output, other systems have used separate flow meters for air and for the water/foam concentrate mix. This arrangement is difficult to operate because it leaves one operator, the engineer, juggling the air and water/foam valves in an attempt to produce the desired output at the end of the hose, while the second operator, the firefighter, at the end of the hose may well be out of sight and out of earshot. So, although the second operator might recognize that the ratio was not what was needed (more or less water/foam concentrate in proportion to air), he might have difficulty conveying to the operator the need for and the kind of change needed for controlling the flow.

It is, therefore, an object of the present invention to provide a compressed air foam fire-fighting system having controls capable of setting and maintaining desired ratios of water/foam concentrate to compressed air.

It is another object of the present invention to provide a fire-fighting system incorporating the above objective, and in which the entire system is built into a framework small enough to fit in the bed of a typical full size pick-up truck.

It is a further object of the present invention to provide a fire-fighting system incorporating the above objectives and in which the ratio of foam concentrate to water is maintained irrespective of a volume of water delivered to the system.

It is a still further object of the present invention to provide a fire-fighting system incorporating the above objectives and which is capable of delivering water, water/foam concentrate, water/foam concentrate mixed with compressed air and air alone.

Other objects and advantages will become apparent from consideration of the following specification taken in connection with the accompanying drawings.

BRIEF SUMMARY OF THE INVENTION

This invention involves a universal fire fighting system, which is designed to be easily transportable by fire fighting personnel to a fire scene where the use of compressed air, foam/water fluids, as well as water alone or aspirated foam/water fluid, is used. The water may be supplied by a portable or fixed tank, a hydrant, or from another water source, such as a lake, stream or a swimming pool

The system, which can be carried on a pick-up truck, includes two small internal combustion engines, one of which drives a water pump, which may be connected to an integral tank or another water source and the other, which drives the air compressor for the system. Each engine has separate, independent controls. A control panel accessible at the rear of the pick-up truck contains controls for the engines, such as ignition and starter switches and choke and throttle controls. A number of gauges are included and switches for controlling the rate of flow of water, water/foam concentrate or compressed air. Valves are included for controlling water input, water or aspirated foam output, or compressed air/foam or air only outputs and a water drain line.

The patented foam mixing system of U.S. Patent 5,009,244 includes a metering valve which can be positioned or set to provide a precisely metered proportion of foam concentrate to water. A differential pressure valve applies discharge water pressure to the foam concentrate as a function of the flow through the main water line. In this manner, the system acts to maintain the desired proportion of foam concentrate to water irrespective of the volume of water delivered. Where only a water/foam solution is desired, this solution is supplied to a specific discharge conduit, including a two-way

valve.

When it is desired to combine the water/foam solution with air, the two-way valve controlling the output of water or water/foam solution is closed and the water/foam solution from the differential pressure valve is supplied to a foam solution metering valve which includes a movable plate having a plurality of ports, each calibrated to a different desired flow rate. The output of the foam solution-metering valve is then fed to an air injection venturi that includes ports for the injection of air into the foam solution from the foam solution-metering valve.

Air, under a substantial known pressure, is supplied by an engine-driven compressor and is fed to an air metering valve which includes a movable plate having a plurality of ports calibrated to supply compressed air in measured quantities at a known pressure. This selected airflow is connected to the air injection venturi which includes a series of ports at the throat of the venturi through which the air is injected. Thus, it will be understood that with precisely calibrated ports in both the foam solution metering valve and the air valve, the ratio of foam solution to air is controlled and maintained, and the system operators can rely on the ratio remaining and the system operators can rely on the ratio remaining as selected.

The modes of operation of this system are:

1. to supply water at the desire flow rate, either
    a) from a self-contained tank or a tank on an associated vehicle; or
    b) from an external source, such as a lake, stream, or swimming pool;
2. to supply a controlled ratio of foam concentrate mixed with water, which ratio remains essentially the same irrespective of the rate of water flow

selected;

3. to supply controlled ratios of compressed air mixed with foam concentrate and water; and

4. to supply compressed air only.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention may be more clearly understood from the following detailed description and by reference to the drawings in which:

Fig. 1 is a perspective view of a truck-mounted system of this invention;

Fig. 2 is a schematic block diagram of this invention;

Fig. 3 is a schematic drawing of the foam supply system of Fig. 2 on an enlarged scale;

Fig. 4 is an exploded view of the foam selector metering valve;

Fig. 5 is a plan view of the metering disk of Fig. 4;

Fig. 6 is a vertical sectional view of the foam selector metering valve of Fig. 4;

Fig. 7 is a perspective view of the foam selector metering valve of Figs. 5-7;

Fig. 8 is a vertical sectional view of the air metering valve;

Fig. 9 is a sectional view taken along line 9-9 of Fig. 8;

Fig. 10 is a vertical sectional view of the air injection venturi of the invention;

Fig. 11 is a sectional view taken along line 11-11 of Fig. 10; and

Fig. 12 is a front elevational view of the control panel of the invention.

DETAILED DESCRIPTION

Referring now to Fig. 1, applicants' fire fighting system **10** is shown carried in the bed of a pick-up truck **PT**. The system **10** is a complete integrated system mounted on and secured to a frame and includes a control panel **11** readily accessible from the back of the pick-up. Also carried in the bed of pick-up truck **PT** are a water tank **12** and a hose reel **14**. All inlet and outlet port valves are located on the control panel.

Fig. 2 is a schematic block diagram of the system **10** in which engine **E1** drives a water pump **18**, which is connected to water tank **12** through a pipe **19** and a two-way valve **21**. Valve **21**, in one position, directs water directly from tank **12** to pump **18**; in its other position, it connects pump **18** with an input line (suction) **27** including a valve **36** for drawing water from an outside source which could be a lake, hydrant, swimming pool or a water truck. Fire fighting water from whatever source is pumped past a check valve **68** to a differential pressure valve **17**, which corresponds to the differential pressure valve of U.S. Patent 5,009,244 referred to above and which is incorporated by reference and attached to this application. Differential pressure valve **17** maintains a pre-set ratio of foam concentrate to water supplied despite wide variations in flow rate of the mixture.

Foam is supplied from a bladder tank **42** which incorporates a flexible bladder **44** containing a Class A foam concentrate, such as the agents sold under the trademark Sylvex of the Ansul Company of Marionette, WI. Bladder **44** is contained within tank **42** such that it is surrounded by water, which is connected to tank **12** through a water conduit **46** from a three-way selector valve **31** in line with differential pressure valve **17**.

The three-way selector valve **31** and metering valve **32**, both of which are described in detail in U.S. Patent 5,009,244, are controlled by means of controls on a selector panel **30** forming part of control panel **11** discussed below. Also connected to three-way selector valve **31** through a conduit **39** is a refill pump **33** which supplies foam concentrate from a source **55** to bladder tank **42**.

WATER/FOAM SUPPLY

Fig. 3 is an enlarged schematic drawing of that portion of Fig. 2 including the water and foam supply system, the differential pressure valve **17**, the three-way selector valve **31**, and the metering valve **32**. Water under pressure from water pump **18** is supplied through check valve **68** to the differential pressure valve **17** where it is mixed with foam concentrate and discharged into conduit **41**.

Foam concentrate in bladder tank **42** is supplied through a line **48** to the three-way selector valve **31**. This valve **31** includes a manual selector for selecting one of three positions which are "foam", "refill" and "off". Water under pressure from water pump **18** is supplied through the differential pressure valve **17**, conduit **50**, three-way selector valve **31**, and from there via line **46** to the tank **42** where it exerts pressure against the outside of bladder **44**, forcing foam concentrate into three-way selector valve **31** via line **48** and to metering valve **32**. During operation when foam concentrate is required, it flows through the three-way selector valve to the metering valve **32** which is graduated to supply the desired percentage of foam concentrate to water, such as 0.2% to 1%.

Differential pressure valve **17**, which is best shown and described in Figs. 9-12 of

U.S. Patent 5,009,244, incorporated by reference herein and includes a pressure responsive internal plate and piston arrangement which senses the differential pressure between the high pressure at the inlet side of valve **17** and the lower pressure at the outlet side. This sensed differential pressure across valve **17** controls the proportioning of foam concentrate to water irrespective of the rate of water flow through valve **17**.

When a water/foam concentrate mixture is desired, metering valve **32** is set to provide the desired ratio of foam concentrate to water. Differential pressure valve **17** responds to water pressure from pump **18** via three-way selector valve **31** to vary the water pressure through conduit **46** against the outside of bladder **44**. This causes foam agent to flow through a line **48** to the three-way selector valve **31** on selector panel **30** discussed above. Foam agent in the selected proportion to water is metered in metering valve **32** which is adjusted to select precisely the desired proportion of foam concentrate to water irrespective of the volume of water flowing through differential pressure valve **17**. Metering or proportioning valve **32** is shown and described in Figs. 6-8 of U.S. Patent 5,009,244 incorporated herein by reference. Foam concentrate in the selected proportion is supplied from metering valve **32** through a conduit **51** to differential pressure valve **17** where it is mixed with water. If only a foam/water mixture is desired, this mixture is supplied from differential pressure valve **17** through a conduit **41** of Fig. 2 to a water/foam solution port on the control panel **11** of Fig. 1 controlled by two-way valve **40** of Fig. 2.

WATER ONLY SUPPLY

If no foam is desired, metering valve **32** is closed and water is supplied from pump **18** through differential pressure valve **17** to conduit **41**. This conduit is connected to a two-way valve **40** on the face of the control panel **11**.

COMPRESSED AIR/FOAM SUPPLY

When a compressed air/foam mixture is desired, valve **40** of Fig. 2 is closed and water/foam concentrate is supplied from the differential pressure valve **17** through a line **53** to a foam selector metering valve **58** (FSMV). This valve includes a plurality of orifices of different sizes, any one of which may be selected for controlling the volume of water/foam concentrate, which is mixed with the air supply. The foam selector metering valve **58** may have, for example, flow settings of 10 GPM (gallons per minute), 20 GPM, 40 GPM, and 80 GPM. More or fewer orifices and different orifice sizes may be chosen. The selected flow is then supplied to an air injection venturi **84**.

The foam selector metering valve **58** is shown in Figs. 4, 5, 6, and 7, and includes a body **90**, a shaft **92**, a disk **94** containing a plurality of orifices **94A, 94B, 94C, 94D, 94E,** and **94F.**, and a cover **96**. The shaft **92**, which is supported at one end in body **90**, and at the other end in cover **96**, carries disk **94**, which is secured to shaft **92** by means of a pin **98**, which seats in a slot **100** in disk **94**. A knob or handle **58a** on the outside of valve **58** (See Fig. 7) turns the shaft **92**, which may be turned to align any of the several orifices shown between inlet passage **102** and outlet passage **104**.

Fig. 5 is a rear elevational view of disk **94** showing its several orifices **94A-F**. Slot **100** is shown in dashed lines indicating that it is not visible in this view.

Fig. 6 is a vertical sectional view through foam selector metering valve **58**. In this view, shaft **92** is shown secured to disk **94** such that, by rotating disk **94**, any of its several orifices may be aligned between inlet passage **102** and outlet passage **104**. A pin **106** is shown urged into a detent **108** by a spring **110**. There are several such detents, one aligned with each orifice to hold disk **94** in the designed selected position.

Fig. 7 is a perspective view of the assembled foam selector metering valve **58**. Visible in this view are the body **90**, the cover **96**, a knob **58a** for turning shaft **92**, and outlet passage **104**. From the foregoing, it will be clear that by turning knob **58a** to any of several positions identified by feeling pin **106** drop into a detent, a desired orifice in disk **94** can be aligned with inlet passage **102** and outlet passage **104**. Particular orifices identified as to flow rates may be identified by aligning an arrow on knob **58a** with marked positions on the control panel **11**, discussed below.

AIR METERING VALVE

As shown in Fig. 2, compressed air from compressor **52** is supplied over line **80** past a cut-off valve **82** to an air metering valve **54**. The output of the air metering valve **54** is supplied to air injection venturi **84** where it is mixed with the water/foam concentrate from foam selector metering valve **58** and the compressed air/foam mixture is supplied through a conduit **60** and a two-way valve **38** for discharge as the output of a compressed air foam system (CAFS) for fire fighting.

Valve **54**, as best seen in Figs. 8 and 9, includes a plurality of orifices sized to supply air at, for example, 25 cubic feet per minute, 35 cubic feet per minute, or 50 cubic feet per minute at the known pressure. The air metering valve **54** is very similar to

valve **58**. Fig. 8 is a vertical sectional view through air metering valve **54** and includes a cover **120**, a body **112**, a shaft **114**, and a disk **116** containing a plurality of orifices of differing sizes, each corresponding to a specific volume of air supplied at a known pressure from the compressor **52** of Fig. 2.

Cover **120** contains an inlet port **122** and body **112** contains an outlet port **124**. Disk **116** contains a detent **126** for each orifice position and is held in a selected radial position by means of a pin **128** urged into detent **126** by a spring **130**. A knob, unshown but represented by the double-ended arrow in Fig. 8 is similar to knob **58a** or a lever may be used to turn shaft **114** to align a desired orifice with inlet passage **122** and outlet passage **124** to provide the desired volume of compressed air.

Fig. 9 is a cross-sectional view taken along line 9-9 of Fig. 8. Body **112** is shown containing disk **116** supported on shaft **114**. Disk **116** is shown with four orifices and four detents **126**, one of which is radially aligned with each orifice. Shown in dotted outline because it is on the opposite face of disk **116** is a pin **132** which sits in a recessed slot **134**. Pin **132** drives disk **116** radially when shaft **114** is rotated.

AIR INJECTION VENTURI

Fig. 10 is a vertical cross-sectional view through the air injection venturi **84**. This unit provides two functions: it includes a venturi for injecting air into the water/foam solution, and a spring-loaded check valve, which blocks water/foam flow until it reaches sufficient pressure to mix properly with the air. A poppet valve **136** in a housing **135** is urged against its seat **138** by means of a spring **140**. An inlet passage **142** connects with a conduit **144** from the foam selector metering valve **58** (Fig. 2). The water/foam

solution crossing poppet valve **136** flows through a venturi **137**, which includes a plurality of ports **145** at its throat which connect to air conduit **56** of Fig. 2. By creating a low pressure at the venturi throat, air is pulled into the stream of water/foam solution where it is combined to provide the desired mixture. The venturi outlet connects to conduit **60**.

Fig. 11 is a cross-sectional view taken along line 11-11 of Fig. 10. Compressed air from conduit **56** is supplied to an inlet port **150** where it enters a toroidal manifold **152** formed in venturi **137**. Connected to manifold **152** are a plurality of passageways **154** leading to ports **145**.

With both air and water pressure controlled and with the precisely sized orifices in both foam selector metering valve **58** and air metering valve **54**, the ratio of water/foam to air remains fixed. There is no need for an operator to balance air and water/foam outputs with flow meters.

AIR ONLY SUPPLY

The system **10** can supply compressed air only from compressor **52** of Fig. 2 in the desired quantity as provided from the air metering valve **54**. In this mode, engine **E1** is shut off or declutched from pump **18**, leaving no water pressure at foam selector metering valve **58**. Air under pressure from air metering valve **54** flows through conduit **56**, check valve **69**, air injection venturi **84**, conduit **60**, and valve **38**.

COMPRESSOR COOLING

The preferred air compressor **52** is of the oil flooded rotary screw type supplying air at a minimum of 50 cubic feet per minute of 125 psi at maximum engine RPM. The compressor **52** is driven by a toothed belt drive from the engine **E2** crankshaft. Water flows through the heat exchanger **72** of Fig. 2 whenever the water pump is operating. The air compressor cooling system incorporates a thermostat that maintains the system oil temperature within a 168 to 225 degree range and is capable of maintaining recommended operating temperatures throughout the full operational range in ambient temperatures up to 115 degrees.

Unheated water from water pump **18** is supplied through a pipe **74** to a shell and tube heat exchanger **72** (HE) in Fig. 2 of all brass and copper construction. A pipe **75** carries cool oil to the lubrication system of compressor **52** where it is exposed to heat, warming the oil in the compressor **52**. The resulting heated oil then flows through a conduit **76** back to the heat exchanger **72** where heat is transferred to the unheated water from pipe **74**. The heated water flows from heat exchanger **72** through a pipe **78** to tank **12**.

The compressor **52** is controlled by a pneumatic modulating inlet valve (not shown) mounted to the air end inlet. This controller senses air pressure and controls the air delivery of the air end while maintaining constant pressure.

In Fig. 12 is shown the control panel **11** of the universal fire fighting system **10**. All of the controls necessary for the normal operation in compressed air foam fire fighting are present including several gages and controls for routine monitoring and maintenance of the engines. Essential water, water/foam, and air controls shown have

been described above.

Near the upper left-hand corner of the panel **11**, there is a key operated ON/OFF switch **SW1**, a throttle **T1**, and a choke control **C1**, for an engine **E1** of Fig. 2, which drives water pump **18**. Part of engine **E1** may be seen through the cooling grid opening **15**. The water pump engine **E1** is an internal combustion engine, preferably a 18 horsepower air cooled Briggs & Stratton Vanguard, 2 cylinder, 4-cycle gasoline engine, which includes an alternator and a 12 volt electric starter operated by key switch **SW1**.

Shown near the upper right hand corner of the panel is a throttle control **T2**, a choke **C2**, as well as an ON/OFF key switch **SW2** for air compressor engine **E2** partly visible through grill **16**. The air compressor motor **E2** is conveniently located on a rear platform above the level of the hose fittings and wobble pump described below.

Upper center on the control panel are two gauges, air pressure gauge **20** and oil pressure gauge **22** for the compressor **52**. Below these two operational gauges are Hobbs meters **24** and **25**, which record running time for the two engines, **E1** and **E2**.

Two other key controls are present on the control panel **11**. They are the sub-panel **30**, which includes controls for the metering valve **32** of Fig. 2 and of U.S. Patent 5,009,244. The panel **30** includes the three-way selector valve **31** for foam proportioning with settings between .02% and 1%. The three-way selector valve corresponding to the selector valve of the foregoing U.S. Patent 5,009,244 appears on panel **30** as selector **32**, which is movable to settings of Refill, Foam, and OFF. The next major control is a three-position turn handle for controlling the air pressure in air metering valve **54** located at the lower left immediately adjacent to the grid opening **15**.

A wobble pump **34** and primer control **35** are located at the lower right-hand area

of the control panel for priming the water pump **18** before commencing operations.

The control panel **11** has all of the water input and output lines and each includes one of the half-inch valves controlled by quarter-turn handles, all of which are shown in Fig. 2 in the "OFF" position. The four lines are water input line **27** controlled by valve **36** (suction), air foam discharge conduit **60** controlled by valve **38**, water/water foam discharge conduit **41** controlled by valve **40**, and water drain **43** controlled by valve **45**.

The system is intended for primary operation with a local water tank, such as a 200-gallon tank **12**, loaded on or near the same skid for the system, or a larger tank up to 1000 gallons, which may be transported with the system. Whenever the system is intended to be used with another source of water, such as a hydrant line or by using the pump of the system to pull water from a stream or other source, the hydrant or other source is connected to the input line **27** and valve **21** is moved to its alternate position.

Also part of control panel **11** is the foam selector metering valve **58** which includes a valve or disc movable to one of four positions to control the volume of output of water or water/foam mixture supplied from the system **10**. The disc may be movable to select, e.g., 10, 20, 40, or 80 gallons per minute of flow supplied to output conduit **60**. As shown in Fig. 2, branching from output conduit **60** is a separate conduit **62**, connected to the hose reel **14** for supplying power to reel the hose in, as required. System drain **35** appears in Fig. 12 on panel **11** at the lower right. Certain minor features, such as individual drains for draining the tank **42** and the pump **48** in freezing weather have not been illustrated.

Altogether, the system of this invention is believed to constitute a universal transportable fire fighting system of greater versatility than heretofore available.

The above-described embodiments of the present invention are merely descriptive of its principles and are not to be considered limiting. The scope of the present invention instead shall be determined from the scope of the following claims including their equivalents.